510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY AND INSTRUMENT COMBINATION TEMPLATE

A. 510(k) Number:

k131988

B. Purpose for Submission:

Device modification- software and labeling changes to the glucose assay only.

C. Measurand:

pH, pO2, pCO2, potassium, sodium, calcium, chloride, glucose, lactate, total hemoglobin, oxygen saturation, FO2Hb, FCOHb, FHHb and FHbF.

D. Type of Test:

Quantitative - Sensors using Potentiometry, Amperometry, Spectrophotometry, and an Optical System for pO2 measurement.

E. Applicant:

Radiometer Medical ApS

F. Proprietary and Established Names:

ABL90 FLEX

G. Regulatory Information:

1. Regulation section:

21CFR 862.1120: Blood gases (pCO2 and pO2) and blood pH test system.
21CFR 862.1600: Potassium test system.
21CFR 862.1345: Glucose test system.
21CFR 862.1170: Chloride test system.
21CFR 864.7425: Carboxyhemoglobin assay.
21CFR 864.5620: Automated hemoglobin system.
21CFR 862.1145: Calcium test system.
21CFR 862.1665: Sodium test system.
21CFR 862.1150: Calibrator.
21CFR 864.7455: Fetal hemoglobin assay.
21CFR 862.1660: Quality control material (assayed and unassayed).
21CFR 862.1450: Lactic acid test system.

2. Classification:
   Class II, II, II, II, II, II, II, II, II, II, I (reserved), I (limitation to exemption per 21 CFR 862.9 (c)(9)), respectively

3. Product code:

   CHL - BLOOD GASES AND BLOOD PH
   CEM - ELECTRODE, ION SPECIFIC, POTASSIUM
   CGA - GLUCOSE OXIDASE, GLUCOSE
   CGZ - ELECTRODE, ION-SPECIFIC, CHLORIDE
   GHS - ASSAY, CARBOXYHEMOGLOBIN
   GKR - SYSTEM, HEMOGLOBIN, AUTOMATED
   JFP - ELECTRODE, ION SPECIFIC, CALCIUM
   JGS - ELECTRODE, ION SPECIFIC, SODIUM
   JIX - CALIBRATOR, MULTI-ANALYTE MIXTURE
   KQI - ASSAY, FETAL HEMOGLOBIN
   JJY - MULTI-ANALYTE CONTROLS, ALL KINDS (ASSAYED AND UNASSAYED)
   KHP - ACID, LACTIC, ENZYMATIC METHOD

4. Panel:

   Clinical Chemistry (75) and Hematology (81)

H. Intended Use:

1. Intended use(s):

   See indications for use below

2. Indication(s) for use:
   The ABL90 FLEX analyzer is a portable, automated analyzer that measures pH, blood gases, electrolytes, glucose, lactate, and oximetry in heparinised whole blood. The ABL90 FLEX analyzer is intended for use by trained technologists, nurses, physicians and therapists. It is intended for use in a laboratory environment, near patient or point-of-care setting. These tests are only performed under a physician's order.
   Indications for use:
   pH, ***p*O2 and *p*CO2:** pH, *p*CO2 and *p*O2 measurements are used in the diagnosis and treatment of life-threatening acid-base disturbances.
   Potassium (*c*K+): potassium measurements are used to monitor electrolyte balance in the diagnosis and treatment of disease conditions characterized by low or high blood potassium levels.
   Sodium (*c*Na+): sodium measurements are used in the diagnosis and treatment of aldosteronism, diabetes insipidus, adrenal hypertension, Addison's disease, dehydration, inappropriate antidiuretic secretion, or other diseases involving electrolyte imbalance.
   Calcium (*c*Ca2+): calcium measurements are used in the diagnosis and treatment of parathyroid disease, a variety of bone diseases, chronic renal disease and tetany.
   Chloride (*c*Cl–): chloride measurements are used in the diagnosis and treatment of electrolyte and metabolic disorders such a cystic fibrosis and diabetic acidosis.

Glucose (*c*Glu): glucose measurements are used in the diagnosis and treatment of carbohydrate metabolism disorders including diabetes mellitus and idiopathic hypoglycemia, and of pancreatic islet cell carcinoma.
Lactate (*c*Lac): The lactate measurements measure the concentration of lactate in plasma. Lactate measurements are used to evaluate the acid-base status and are used in the diagnosis and treatment of lactic acidosis (abnormally high acidity of the blood.)
Total Hemoglobin (*c*tHb): total hemoglobin measurements are used to measure the hemoglobin content of whole blood for the detection of anemia.
***s*O2:** oxygen saturation, more specifically the ratio between the concentration of oxyhemoglobin and oxyhemoglobin plus reduced hemoglobin.
***F*O2Hb:** oxyhemoglobin as a fraction of total hemoglobin.
***F*COHb:** carboxyhemoglobin measurements are used to determine the carboxyhemoglobin content of human blood as an aid in the diagnosis of carbon monoxide poisoning.
***F*MetHb:** methemoglobin as a fraction of total hemoglobin.
***F*HHb:** reduced hemoglobin as a fraction of total hemoglobin.
Fraction of Fetal Hemoglobin (*F*HbF): FHbF indicates the amount of fetal hemoglobin. *F*HbF is seldom used clinically.

3. Special conditions for use statement(s):

   For prescription use only.

4. Special instrument requirements:

   ABL90 FLEX analyzer

I. Device Description:

The ABL90 FLEX is a portable, automated system intended for in vitro testing of samples of whole blood for the parameters pH, pO2, pCO2, potassium, sodium, calcium, chloride, glucose, lactate, and co-oximetry parameters (total hemoglobin, oxygen saturation, and the hemoglobin fractions FO2Hb, FCOHb, F MetHb, FHHb and FHbF).

J. Substantial Equivalence Information:

1. Predicate device name(s):
   ABL90 FLEX

2. Predicate 510(k) number(s):
   k122729

3. Comparison with predicate:

Similarities		
Item	Device ABL90 Flex	Predicate ABL90 Flex (k122729)
	The ABL90 FLEX analyzer is a portable, automated	

Similarities		
Item	Device ABL90 Flex	Predicate ABL90 Flex (k122729)
Intended use	analyzer that measures pH, blood gases, electrolytes, glucose, lactate, and oximetry in heparinized whole blood. The ABL90 FLEX analyzer is intended for use by trained technologists, nurses, physicians and therapists. It is intended for use in a laboratory environment, near patient or point-of-care setting. These tests are only performed under a physician's order.	Same
Intended use site	Laboratory and point-of-care.	Same
Blood Gas Measurement	pH, pO2, pCO2 by potentiometry	Same
Electrolyte Measurement	cK+, cNa+, cCa2+, cCl- by potentiometry	Same
Metabolite Measurement	cGlu, cLac by amperometry Glucose: Oxidase	Same
Oximetry Measurement	ctHb, sO2 FO2Hb, FHHb, FCOHb, FMetHb, FHbF	Same
User Interface	Menu driven touch screen	Same
Software operating system	Microsoft XPE	Same
Sample Introduction	Aspiration	Same
Dimensions (height x width x depth)	17.7 x 9.8 x 11.4	Same

Differences		
Item	Device ABL90 Flex	Predicate ABL90 Flex (k122729)
Caution in Manual	Low *p*O2 levels can influence the linearity of glucose measurements, and can therefore result in falsely low glucose results. Please note that glucose performance is not specified	Low *p*O2 levels can influence the linearity of glucose measurements, and can therefore result in falsely low glucose results. Please note that glucose performance is not

Differences		
Item	Device ABL90 Flex	Predicate ABL90 Flex (k122729)
	when the *p*O2 is less than *10 mmHg (1.33 kPa)*. The linearity of the glucose is dependent on the oxygen tension of the sample. This dependence is due to the co-reaction of glucose and oxygen by the enzyme glucose oxidase. Low *p*O2 levels can influence the linearity of the glucose sensor. A table which outlines the glucose linearity as a function of the *p*O2 is provided in the operators' manual.	specified when the *p*O2 is less than 25 mmHg (3.33 kPa). The linearity of the glucose is dependent on the oxygen tension of the sample. This dependence is due to the co-reaction of glucose and oxygen by the enzyme glucose oxidase. Low *p*O2 levels can influence the linearity of the glucose sensor. A table which outlines the glucose linearity as a function of the *p*O2 is provided in the operators' manual.
Software change	Software changes: - Suppression of glucose results when *p*O2 < 10 mmHg - Suppression of glucose results >270mg/dL when *p*O2 is between 10 - 25mmHg - Message: "Glu not usable"	Software changes: - Suppression of glucose results when *p*O2 < 25 mmHg - Message: "Glu not usable"

K. Standard/Guidance Document Referenced (if applicable):

None referenced

L. Test Principle:

There are four different measuring principles employed in the sensors in the ABL90 FLEX analyzer.

Potentiometry: The potential of a sensor chain is recorded using a voltmeter, and related to the concentration of the sample (the Nernst equation). The potentiometric measuring principle is applied in the pH, pCO2, K+, Na+, Ca2+ and Cl- sensors.

Amperometry: The magnitude of an electrical current flowing through a sensor chain is proportional to the concentration of the substance being oxidized or reduced at an electrode in the chain. The Amperometric measuring principle is applied in the cGlu and cLac sensors.

Optical pO2: The optical system for pO2 is based on the ability of O2 to reduce the intensity and time constant of the phosphorescence from a phosphorescent dye that is in contact with the sample. This measuring principle is applied in the pO2 sensor.

Spectrophotometry: Light passes through a cuvette containing a hemolyzed blood sample. The specific wavelengths absorbed and their intensity generates an absorption spectrum used to calculate oximetry parameters. This measuring principle is used for measuring ctHb, sO2, FO2Hb, FCOHb, FHHb, FMetHb, and FHbF.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. Precision/Reproducibility:

An in-house, 20-day precision study was performed in accordance with the CLSI guideline EP5-A2. This study evaluated the precision performance of the ABL90 at three levels of whole blood glucose (approximately 18 mg/dL, 99 mg/dL, and 270 mg/dL) in combinations at three different levels of pO2 concentrations (approximately 10 mmHg, 30 mmHg, and > 90 mmHg). The heparinized, whole blood sample combinations were analyzed in duplicate, on three instruments, in 2 runs per day, for 20 days for a total of 240 runs per glucose-pO2 concentration combination. The between-day and total precision is summarized in the tables below.

Glucose Low

				Between-Day		Total	
ABL90 Analyzer	pO2 mmHg	n	Glucose Mean mg/dL	SD	CV%	SD	CV%
1	10	80	17.5	0.54	3.1		
2	10	80	18.5	1.26	6.8		
3	10	80	17.8	0.52	2.9		
Combined	10	240	17.9			0.8	4.7
1	30	80	17.6	0.50	2.8		
2	30	80	18.5	1.14	6.1		
3	30	80	17.8	0.46	2.6		
Combined	30	240	18.0			0.8	4.3
1	>90	80	17.7	0.49	2.8		
2	>90	80	18.6	1.10.	5.9		
3	>90	80	17.9	0.42	2.3		
Combined	>90	240	18.1			0.7	4.1

Glucose Medium

				Between-Day		Total	
ABL90 Analyzer	pO2 mmHg	n	Glucose Mean mg/dL	SD	CV%	SD	CV%
1	10	80	101.1	2.46	2.5		
2	10	80	104.3	5.54	5.3		
3	10	80	99.9	2.51	2.5		
Combined	10	240	101.7			3.8	3.7
1	30	80	100.4	2.32	2.3		

2	30	80	102.5	4.78	4.7		
3	30	80	100.2	2.28	2.3		
Combined	30	240	101.0			3.3	3.3
1	>90	80	100.3	2.29	2.3		
2	>90	80	101.5	4.72	4.7		
3	>90	80	101.8	2.16	2.1		
Combined	>90	240	101.2			3.3	3.2

Glucose High

				Between-Day		Total	
ABL90 Analyzer	pO2 mmHg	n	Glucose Mean mg/dL	SD	CV%	SD	CV%
1	10	80	258.6	9.65	3.7		
2	10	80	251.7	12.96	5.2		
3	10	80	252.0	9.36	3.7		
Combined	10	240	254.1			10.8	4.2
1	30	80	263.5	7.45	2.8		
2	30	80	263.9	11.72	4.4		
3	30	80	258.6	6.39	2.5		
Combined	30	240	259.6			8.8	3.4
1	>90	80	270.8	4.85	1.8		
2	>90	80	274.6	10.92	4.0		
3	>90	80	270.3	4.80	1.8		
Combined	>90	240	271.9			7.4	2.7

b. *Linearity/assay reportable range:*

The performance data submitted in the original submission, k092686 still apply.

c. *Traceability, Stability, Expected values (controls, calibrators, or methods):*

The performance data submitted in the original submission, k092686 still apply.

d. *Detection limit:*

The performance data submitted in the original submission, k092686 still apply.

e. *Analytical specificity:*

An interference study was performed to evaluate the effect of pO2 and interfering substance in glucose measurement and to determine the upper measurable limit for glucose measurements in samples with pO2 concentrations between 10 and 80 mmHg. Freshly drawn heparinized human blood samples were tonometrated until the desired pO2 concentrations were achieved. Each glucose level was measured in series, starting with pO2 ≥90 mmHg as a control and alternating with the same concentration of glucose at lower pO2 concentrations of 80, 50, 25, 20, 15, and 10 mmHg. Seven glucose levels (9, 36, 79,119, 180, 270, and 450 mg/dL) were measured in replicates of 6 on each of the 3 analyzers, with two runs on

different days throughout the test period. The total number of measurements during the study was 1512. The sponsor defines interference as > ±10% bias between the tested samples and the control samples. The data is summarized in the table below.

Results of Interference Study:							
% difference		***pO2***					
		10	**15**	**20**	**25**	**50**	**80**
***cGlu* [mg/dL]**	**9**	3.3%	3.1%	3.4%	1.1%	3.8%	0.0%
	36	1.3%	1.3%	0.8%	0.5%	0.9%	0.2%
	79	2.0%	1.6%	0.7%	0.8%	0.9%	0.6%
	119	2.0%	1.5%	1.5%	0.9%	1.3%	0.4%
	180	4.7%	2.7%	2.5%	0.9%	0.3%	0.6%
	270	7.0%	6.1%	3.1%	2.4%	2.0%	1.1%
	450	13.6%	9.3%	7.1%	3.8%	5.0%	0.7%

Based on the interference results, the sponsor claims that the pO2 level between 10 to 25 mmHg will not significantly affect the glucose results of less than 270 mg/dL. In addition, the glucose result of >270 mg/dL for sample with pO2 level between 10 and 25 mmHg will be suppressed and a message of "Glu not usable" will appear; the user should use an alternative method to measure the glucose result in this case. Sponsor has provided a warning of this limitation in the operator's manual.

f. Assay cut-off:

Not applicable.

2. Comparison studies:

a. Method comparison with predicate device:

An in-house method comparison study was performed to verify bias of the glucose parameter between the ABL90 and the comparator device, the ABL735, when measuring whole blood samples with pO2 tension in the interval of 10 mmHg to 25 mmHg and glucose concentrations of between 9.0 mg/dL and 270 mg/dL. Three separate pairs of ABL90 and ABL735 analyzers were used throughout the method comparison study to simulate three external POC sites. Freshly drawn heparinized whole blood samples were tonometrated until desired pO2 levels were achieved. The samples were then measured on each of three ABL90/ABL735 paired analyzers. Testing was performed for 11 consecutive days. 510 data points were obtained on each of the ABL90/ABL735 pairs. ABL90 Flex vs. ABL735 regression analysis for glucose method comparison of samples with pO2 between 10 mmHg and 25 mmHg is summarized in the below table for each of the three instrument pairs:

ABL90 FLEX and ABL735 Method Comparison Regression Analysis

Analyzer	n	Slope	Intercept	R^2
1	510	0.912	0.004	0.990
2	510	0.907	0.237	0.984
3	510	0.940	0.033	0.984
Combined	1530	0.921	0.084	0.990

b. Matrix comparison:

Only matrix recommended for ABL90FLEX is heparinized whole blood.

3. Clinical studies:

a. Clinical Sensitivity:

Not applicable

b. Clinical specificity:

Not applicable

c. Other clinical supportive data (when a. and b. are not applicable):

Not applicable

4. Clinical cut-off:

Not applicable

5. Expected values/Reference range:

Parameter	Population	Reference range	Cited from
pH,	Children, adults	7.35-7.45	Tietz 2008
pCO_2	Female	4.3-6.0 kPa	Tietz 2008
	Male	4.7-6.4 kPa	Tietz 2008
pO_2	2days- 60years	11.0-14.4 kPa	Tietz 2008
cK^+	Male, female	3.4-4.5 meq/L	Tietz 1987
cNa^+	Male, female	136-146 meq/L	Tietz 1987
cCa^{2+}	Adult	2.30-2.66 meq/L	Tietz 2008
cCl^-	Adult	98-107 meq/L	Tietz 2008
*c*Glucose	Adult	65-95 mg/dL	Tietz 2008
*c*Lactate	Female, male	4.5-14.4 mg/L	Tietz 1987
	At bed rest	3.0-7.0 mg/L	Tietz 2008
*c*tHb	Female	12.0-16.0 g/dL	Tietz 1987
	Male	13.5-17.5 g/dL	Tietz 1987

N. Instrument Name:

ABL90 FLEX

O. System Descriptions:

1. Modes of Operation:

Single sample mode

2. Software:

   FDA has reviewed applicant's Hazard Analysis and software development processes for this line of product types:

   Yes ____x____ or No _____

3. Specimen Identification:

   Single sample

4. Specimen Sampling and Handling:

   This device is intended to be used with whole blood samples.

5. Calibration:

   Two-point liquid calibration, calibration and QC reagents plus a waste reservoir are contained in one solution pack. "Smartchip "technology for unique identification and lot specific calibration and quality control data.

6. Quality Control:

   QC reagents plus a waste reservoir are contained in one solution pack. "Smartchip "technology for unique identification and lot specific calibration and quality control data.

   The sponsor states that the user should "Follow federal, state and local guidelines for testing quality control materials," in the operator manual.

P. Other Supportive Instrument Performance Characteristics Data Not Covered In The "Performance Characteristics" Section above:

None

Q. Proposed Labeling:

The labeling is sufficient and it satisfies the requirements of 21 CFR Part 809.10.

R. Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.